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REPORT

Sustaining the U.S. Air Force Nuclear Mission

Don Snyder • Sarah A. Nowak • Mahyar A. Amouzegar • Julie Kim • Richard Mesic

PROJECT AIR FORCE

REPORT

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Preface

The U.S. Air Force (USAF) nuclear enterprise is renewing its focus on strengthening the nuclear deterrence mission. Many ongoing efforts, both inside and outside the Air Force, have been analyzing the enterprise to identify any deficiencies for remediation. While the work reported here also considers how the Air Force might be able to continue to strengthen its nuclear deterrence mission, it contrasts with other similar efforts in that the emphasis is more on finding better long-term practices than on identifying current problems. It looks beyond the current state of the enterprise to find ways to help ensure that current USAF capabilities can be affordably sustained well into the future.

The research reported here was completed as part of a fiscal year 2011 project entitled "Nuclear Sustainment Roles and Responsibilities." The work was conducted within the Resource Management Program of RAND Project AIR FORCE and was sponsored by the Commander of the Air Force Nuclear Weapons Center (AFNWC/CC). Although sponsored by the AFNWC, the scope is broader than the purview of the AFNWC and includes the full breadth of sustaining the nuclear mission. The findings apply across the Air Force, and implementing the recommendations would require participation of numerous commands and the Air Staff. This report is intended to help the Air Force better manage sustainment activities within the nuclear enterprise and should be of direct interest to all those working in the Air Force nuclear enterprise.

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Summary

The biggest challenge likely to confront the U.S. Air Force (USAF) nuclear enterprise in the near future is how to cope with declining total obligation authority and a smaller force structure. To meet this challenge, the USAF needs to have the best processes and tools available to allocate resources across sustainment of all systems in the nuclear enterprise in a way that most efficiently and effectively fulfills its portion of the national nuclear mission. The purpose of this report is to identify ways to strengthen future nuclear deterrence capabilities by better planning and programming for the sustainment of these missions in the present.

This cannot be done well by focusing alone on the sustainment of individual platforms. It requires a mission-based planning view that embraces how the various systems work together to perform a mission. For example, for a mission such as nuclear long-range standoff, this integrates the sustainment, modernization, and recapitalization plans for the W80 nuclear warhead; the air-launched cruise missile that carries it; the B-52H that carries the missile; and the relevant nuclear command, control, and communications (NC3) systems that support them. Sustainment in this context also extends to the full doctrine (and policy), organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF) set of resources, processes, and activities needed to ensure the provision of a continuous, reliable capability to fully execute the missions specified by national guidance for some duration into the future.

To position itself most strongly to overcome budgetary pressures and possible reductions in force structure, the Air Force should further strengthen its integrated processes for nuclear mission-based planning with a framework that has two layers, the first consisting of a lower set of sustainment plans for each system, maintained by a system program office (for the weapon systems) or project officers group (for the nuclear weapons). These would follow a common format to facilitate integration and, in time, would present a schedule of activities that exploits the capabilities of information technology systems. The second layer would consist of an integrated master plan that pulls together the salient information from these individual, system-level plans, compiling the individual plans into a master schedule for all systems, taking into account the sustainment and modernization of the current platforms and any need for future recapitalization. We call this an Air Force Nuclear Architecture and Mission Sustainment Plan. It would be the master plan for the nuclear enterprise, detailing how the long-term mission will be sustained, would be guided by national-level guidance, and would serve as the Air Force's input into a Department of Defense nuclear architecture.

Most of the needed elements are in place, but some additions could potentially pay great dividends. Some kind of life-cycle sustainment plan exists for all of the nuclear systems with the exception of the NC3 systems. However, no master integration plan for the nuclear mission lays out the future, integrated calendar for all the systems in a way that monitors and trace-

ably documents the implications of resource allocations and schedule slips. We make a number of recommendations in this report, but in the hierarchy of actions to put in place a complete mission-based planning process for sustainment, the two most promising first steps are to (1) consolidate responsibility for the architecture, systems engineering, and sustaining engineering for Air Force NC3 into a single organization, and (2) create what we call an Air Force Nuclear Architecture and Mission Sustainment Plan. This plan would integrate the sustainment plans of all the nuclear systems, emphasizing a master integrated calendar of activities, and, in time, presenting and monitoring these plans using the capabilities of modern information technology systems.

The anticipated benefits are to strengthen the credibility of the future nuclear mission by improving oversight of the NC3 mission, better integrating these decisions with other related systems, and better monitoring and managing an integrated set of DOTMLPF-based plans for sustaining the most effective and efficient nuclear mission into the future.

Acknowledgments

We thank Maj Gen Everett Thomas, then Commander of the Air Force Nuclear Weapons Center, for requesting this work, sponsoring its initial phases, and supporting its execution. (All ranks listed were current as of the time of our meetings.) We equally thank Brig Gen Garrett Harencak for embracing the project as its second sponsor. We benefited from discussions with many individuals in the Air Force, too numerous to mention.

Lt Col Lance Adkins and Lt Col Laura Garrett have been excellent action officers for the study; the project could not have been done without them.

At RAND, we especially thank Ryan Britton, John Drew, Robert Elder, and Tim Molnar for their insights, and George Nacouzi for many helpful discussions about the nuclear command, control, and communications systems. Paul DeLuca and Ronald McGarvey provided helpful, constructive reviews.

That we received help and insights from those acknowledged above should not be taken to imply that they concur with the views expressed in this report. We alone are responsible for the content, to include any errors or oversights.

Abbreviations

AFGLSC	Air Force Global Logistics Support Center
AFGSC	Air Force Global Strike Command
AFGSC/A6	Directorate of Communications and Information, Air Force Global Strike Command
AFI	Air Force Instruction
AFMC	Air Force Materiel Command
AFNWC	Air Force Nuclear Weapons Center
AFPAM	Air Force Pamphlet
AFPD	Air Force Policy Directive
ALCM	Air-launched cruise missile
C2	command and control
CFLI	Core Function Lead Integrator
DoD	Department of Defense
DoE	Department of Energy
DOTMLPF	doctrine (and policy), organization, training, materiel, leadership and education, personnel, and facilities
ESC	Electronic Systems Center
GAO	Government Accountability Office
GBSD	ground-based strategic deterrent
ICBM	intercontinental ballistic missile
ITW	integrated tactical warning
LPO	lead project officer
MMIII	Minuteman III
NC3	nuclear command, control, and communications

NNSA	National Nuclear Security Administration
NPR	Nuclear Posture Review
NWC	Nuclear Weapons Council
PAF	Project AIR FORCE
PEO	program executive officer
POG	project officers group
SPO	system program office
USAF	U.S. Air Force
U.S.C.	U.S. Code
USSTRATCOM	U.S. Strategic Command

CHAPTER ONE

A Mission-Based View of Sustainment

"Weapons deter by the possibility of their use, and by no other route."

— Michael Quinlan[1]

U.S. nuclear deterrence is no more effective than our ability to carry out nuclear operations and other states' perceptions of this ability. If weapons are not reliable, delivery systems are grounded, or personnel become inadequately trained, deterrence can dangerously degrade. We use the term *sustainment of the nuclear mission* (or capabilities) to describe processes and actions that ensure the nuclear deterrence mission into the future. We contrast this definition with that of the sustainment of a *platform*, broadening the concept of sustainment to mean the sustainment of the doctrine (and policy), organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF) set of resources, processes, and activities needed to ensure the provision of a continuous, reliable capability to fully execute the missions specified by national guidance for some duration into the future. The sustainment of a safe, secure, and effective nuclear mission (and capabilities) is central to maintaining a credible strategic deterrent.[2]

Over the past several years, the U.S. Air Force (USAF) has made it a top priority to reinvigorate and further strengthen its nuclear enterprise. In the course of these still ongoing activities, numerous reviews of a wide range of types and scopes have probed the enterprise, resulting in a plethora of findings and recommendations. These efforts touch on the full ambit of the nuclear enterprise, to include the sustainment of the nuclear mission (e.g., the various Comprehensive Assessments of Nuclear Sustainment and the work of the Defense Science Board[3]).

The work presented in this report takes a different tack. Rather than focusing on details of what may be currently imperfect in the sustainment of the nuclear mission, we focus on what may be done to build a stronger future state. We outline a framework for sustaining the nuclear mission, describe challenges faced in sustaining the capabilities provided by nuclear systems of systems, and recommend courses of action to mitigate those challenges. The goal is to identify

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[1] Michael Quinlan, *Thinking About Nuclear Weapons: Principles, Problems, Prospects,* New York: Oxford University Press, 2009, p. 26.

[2] See U.S. Department of Defense (DoD), *Nuclear Posture Review Report,* Washington, D.C., April 2010.

[3] In particular, see Defense Science Board, *Report of the Defense Science Board Permanent Task Force on Nuclear Weapons Surety: Independent Assessment of the Air Force Nuclear Enterprise,* Washington, D.C.: Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, April 2011.

ways to strengthen future nuclear deterrence capabilities by better planning and programming for the sustainment of these missions in the present.

Budgetary Constraints

In pursuing this approach, we emphasize that the DoD faces near- and potentially long-term budgetary pressures and that these pressures are likely to be the most pressing challenge that the nuclear enterprise faces in the foreseeable future. Budgetary pressures narrow the options available to planners and programmers, amplifying the consequences of any imprecision in the balancing of resource allocations across programs.[4] A planning framework for nuclear sustainment is needed—one that reflects capabilities rendered for obligated dollars to minimize the risk that the Air Force nuclear enterprise will face in the event of real decreases in future total obligation authority.

In this chapter, we describe a framework for managing the sustainment of the nuclear mission that emphasizes the sustainment of missions over platforms and the integration of efforts across organizational boundaries. In the next chapter, we examine where the Air Force can further strengthen its processes along these lines and make recommendations for areas of the most profitable changes. Before describing this sustainment framework, we address the aspects of the nuclear enterprise that make it unique relative to other Air Force missions and how these attributes pertain to sustainment of the nuclear mission.

Scope: What Is Unique About the Nuclear Enterprise?

Some aspects of sustainment that the Air Force nuclear enterprise struggles with—be it supply chain management, enterprise resource planning tools, sustaining engineering, or any other area—are not unique to the nuclear enterprise. It is beyond the scope of this report to address the full range of challenges, across the entire Air Force enterprise, that the Air Force faces with regard to sustainment. Nor should the nuclear enterprise try to address these issues on its own; rather, it should partner with the rest of the Air Force. Therefore, we focus on those aspects that are either unique to the nuclear enterprise or require thinking about the nuclear enterprise in its totality to be adequately addressed.

Although the sustainment of the nuclear mission has much in common with the sustainment of conventional capabilities, several aspects are different. Some of these differences introduce unique challenges, and others somewhat simplify the difficulties of nuclear sustainment. Either way, it is important to understand what makes this mission distinct from other Air Force missions and why it warrants separate attention with regard to sustainment.

Foremost among these unique aspects is the nature of the mission itself: deterrence and extended deterrence, which are as much about political effects as military effects. These objectives are relevant to sustainment because sustainment is ultimately the long-term maintenance of a capability, and the degree to which that effort is successful depends on whether these

[4] Note that the Schlesinger Task Force attributed inappropriate resource allocation for the nuclear deterrence mission as one cause of a degradation in nuclear mission readiness. See James R. Schlesinger, *Report of the Secretary of Defense Task Force on DoD Nuclear Weapons Management: Phase I: The Air Force's Nuclear Mission,* September 2008, p. 6.

mission objectives are met. Measures of the success of deterrence are needed to best allocate limited resources in the sustainment effort, but such measures are, in general, far more elusive for nuclear deterrence than they are for conventional missions. We take up this topic in more detail in the next chapter.

In addition, because the nuclear mission is principally one of deterrence, sustainment does not merely *support* the mission of deterrence but is itself an *integral part of the deterrence mission*. Deterrence is only as effective as the capability is credible, so when sustainment efforts are highly visible and announce that credibility to an adversary whom we wish to influence, they deter. The several test launches of the Minuteman III (MMIII) out of Vandenberg Air Force Base each year are a salient example of this direct contribution of sustainment to deterrence.

This effect works the other way as well: If an entire fleet of dual-capable aircraft were grounded, perhaps due to a structural integrity issue, it would be a visible indication of a lack of a credible deterrent in one portion of the nuclear triad and hence could potentially directly weaken the deterrent. In this sense, sustainment plays a central role in the nuclear mission and factors into the decision calculus of resource allocation in a way that differs from most conventional capabilities, suggesting that credibility of deterrence can be augmented by a robust, visible sustainment effort.

Another way in which the sustainment of the nuclear mission differs from other Air Force missions is the intrinsic interagency boundary that cuts through the mission. The nuclear arsenal is owned and managed by the Department of Energy (DoE), whereas the delivery platforms and all other military systems for employing the weapons are under the authority of the DoD. Neither the DoE nor the DoD can, in isolation, provide a nuclear deterrent. They must work together in a collaborative effort. Navigating this interagency boundary in a way that most effectively and efficiently sustains this integrated capability has its unique challenges.

But not all the unique aspects of the nuclear mission present challenges. The nature of the nuclear mission in some ways makes the problem of long-term sustainment easier. Relative to other mission areas, such as the especially challenging cyber operations, the nature of the nuclear mission is fairly stable, and its technologies are mature. Further, national-level strategic guidance for the nuclear mission is clear, is bounded in how it might change, and places heavy constraints on the options available to the Air Force, all the way down to force structure levels. This clarity and stability allows the Air Force to do longer-term planning and to commit to programmatic decisions with less risk than in most other mission areas.[5]

We will emphasize these intrinsically nuclear aspects of the nuclear sustainment challenges in more depth in the next chapter. To set up that discussion, we outline a general framework for thinking about the sustainment of the nuclear mission to show how the range of sustainment efforts work together cohesively to fulfill the nuclear mission. This framework will reveal any potential weak links in the integrated whole and, hence, where maximal benefit would accrue by further strengthening nuclear enterprise planning and programming for sustainment.

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[5] For example, contrast the spirit of uncertainty for force structure in DoD, 2010; and in U.S. Air Force, *Strategic Planning 2010–2030: Strategic Environmental Assessment,* Washington, D.C.: Directorate of Strategic Planning, Headquarters United States Air Force (AF/A8X), March 11, 2011.

Approach and Perspective

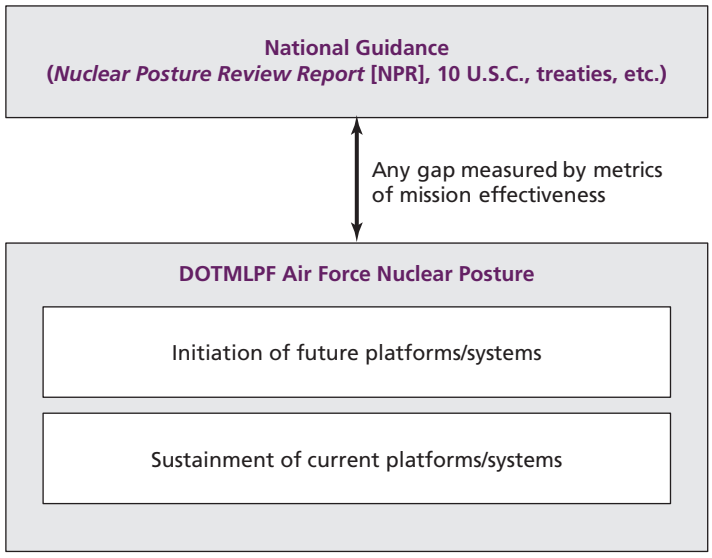
The approach we take conforms to a mission-based planning paradigm. It emphasizes how the individual components of the nuclear enterprise work together to fulfill the nuclear mission rather than how to sustain the individual platforms in isolation. So, we adopt an overarching framework for sustaining the nuclear *mission*, emphasizing how the various systems and platforms integrate with one another to provide the necessary mission capabilities, as well as aspects of how DOTMLPF elements combine to form the nuclear capabilities.

From this, we describe a way to manage the sustainment of the nuclear mission by identifying any existing gaps and ways in which integration might be improved. We pay special attention to those elements that would make planning and programming result in a more effective and efficient future nuclear enterprise. Although the sustainment of *platforms* plays an integral part of this framework, the perspective we take is broader than the current focus on individual platforms and systems—the sum total of the DOTMLPF components needs to be sustained. In the remainder of this chapter, we describe this framework. In the next chapter, we discuss ways to further strengthen the sustainment of the nuclear mission.

The Framework

Figure 1.1 shows the higher-level structure of this framework. The components of DOTMLPF combine to form an integrated Air Force Nuclear Architecture that will allow the Air Force to provide the future nuclear capabilities called for in national guidance, both now and into the future. This architecture is represented by the lower shaded box. We will describe this architecture in detail below, but, for now, we point out that an integral part of it is the various platforms and systems that combine to fulfill the mission. Two aspects of the sustainment of the nuclear mission are the sustainment of the current platforms and systems (depicted by the lower white box) and the future force mix of platforms, to include recapitalization (depicted by the upper white box).

Figure 1.1
A Framework for the Sustainment of the Nuclear Mission



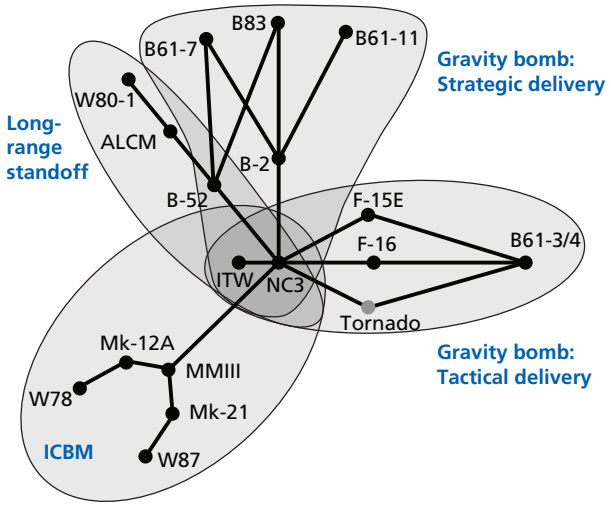
RAND *TR1240-1.1*

National guidance is indicated by the upper shaded box in Figure 1.1 and emanates from a range of sources, including the *Nuclear Posture Review Report*, congressional statute, treaties to which the United States is a signatory, and DoD orders. Compared to many other missions, such as cyber operations and conventional strike, the general contours of the future nuclear mission and constraints on force structure and posture are easily discerned. The technologies are relatively mature, and in the foreseeable future, some general constraints are clear: It is likely that the number of weapons in the stockpile will be no more than the current inventory, no new weapons are likely to be developed, no weapons testing is likely to be done, the force structure of delivery platforms is likely to be no more than the current levels, and the overall goals of nuclear deterrence and extended deterrence are likely to remain stable.[6] Although stockpile levels and numbers of delivery systems are likely to be renegotiated some time in the future, and the threat environment might evolve, the overall stability of the nuclear mission and the sense of the direction of change in force levels help ease the burden of developing a long-term strategy for sustaining the nuclear mission that is not upended by significant changes in either national objectives, new technologies, or international relations.

The Nuclear System of Systems

Now, digging more deeply into the lower shaded box in Figure 1.1, we look at how current platforms and systems combine to fulfill the nuclear mission. This slice of sustainment of the nuclear mission focuses only on a portion of the materiel part of DOTMLPF. There is more than one way to express these capabilities. We bin them into the groups shown in Figure 1.2: intercontinental ballistic missile (ICBM) capability, a long-range standoff missile capability,

Figure 1.2
The Current Nuclear Enterprise as a System of Systems



NOTE: ALCM = air-launched cruise missile; ITW = integrated tactical warning; and NC3 = nuclear command, control, and communications.

RAND *TR1240-1.2*

[6] DoD, 2010.

and a gravity bomb capability. The latter can be further subdivided by distinguishing between strategic and tactical delivery.

As with conventional operations, each of these capabilities or missions requires that a number of different systems function in an integrated fashion to accomplish the desired effect, whether that effect is the destruction of a target or the alteration of the decision calculus of an adversary through deterrence. Figure 1.2 depicts this general interconnectedness of selected major systems that combine as a system of systems to create the Air Force's nuclear capabilities, which, in turn, combine with those of the Navy to form the nation's nuclear triad.[7] At the outer part of the system of systems are the weapons. For example, the ability to employ a long-range standoff weapon requires—at minimum—the readiness of the weapon, the cruise missile, the delivery aircraft, the NC3 systems, and the ITW system. The mission is accomplished by the mutual workings of a system of systems. In the case of the standoff mission, the weapon is the W80-1 warhead, which is carried by the ALCM,[8] which in turn is carried by the B-52H bomber. The B-52H is enabled by an NC3 system and an ITW system. Weakness in the sustainment of any one of these renders the entire mission less effective, and hence there is a need for an overall vision for the sustainment of the mission, not just the platforms.

From a sustainment standpoint, one of the most important aspects of this interconnectedness is what we will call *scheduling*. Each of these systems undergoes modernization, life-extension programs, and other efforts to ensure their readiness until their planned retirement date. All of these activities are planned to occur according to a schedule, which is documented in varying levels of detail in some form of a life-cycle master plan.[9] When these scheduling decisions are made for a given system without regard to the scheduling of sustainment activities in other systems, inefficiencies can result. For example, a decision might be made to slip the life-extension program schedule for a weapon for reasons that will reduce costs within that program or within that agency. But, that slippage might cause schedule delays or increased integration complexities that increase costs to numerous other systems that must work in concert with the weapon.

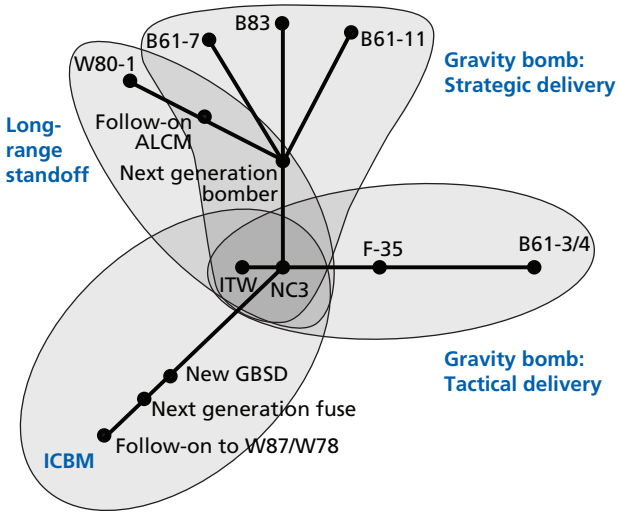
Beyond the life-cycle sustainment plans for individual systems, the way in which the nuclear mission is fulfilled evolves over time. As current systems become too expensive to sustain, or threats evolve that require new capabilities, new systems may be needed to support the mission. Depictions such as that of Figure 1.2 need to be specified for various times in the future. For example, some time in the future, the network shown in Figure 1.2 may look like the one shown in Figure 1.3. For the standoff nuclear mission, the weapon may be the same (the W80-1 or a life-extended version of the W80-1), but the cruise missile may be a new platform, and that missile may be delivered by a different platform. New systems may not be one-

[7] Other important systems include aerial refuelers, primary nuclear airlift forces, etc., which are omitted to simplify the diagram.

[8] Also known as the AGM-86B.

[9] Most systems have some kind of life-cycle master plan, which can take many different formats and names (e.g., roadmaps, flight plans, weapon system integrity plans, master plans, and so forth). Current guidance for these plans for Air Force systems are given by Air Force Policy Directive (AFPD) 63-1, *Integrated Life Cycle Management,* July 3, 2012; Air Force Instruction (AFI) 63-101, *Acquisition and Sustainment Life Cycle Management,* April 17, 2009, Incorporating through Change 3, October 26, 2010; and Air Force Pamphlet (AFPAM) 63-128, *Guide to Acquisition and Sustainment Life Cycle Management,* October 5, 2009.

Figure 1.3
A Potential Future Nuclear Enterprise as a System of Systems



NOTE: GBSD = ground-based strategic deterrent.

RAND *TR1240-1.3*

to-one replacements of legacy systems, such as the planned F-35 replacement of the F-16 and F-15E (and alliance Tornado).

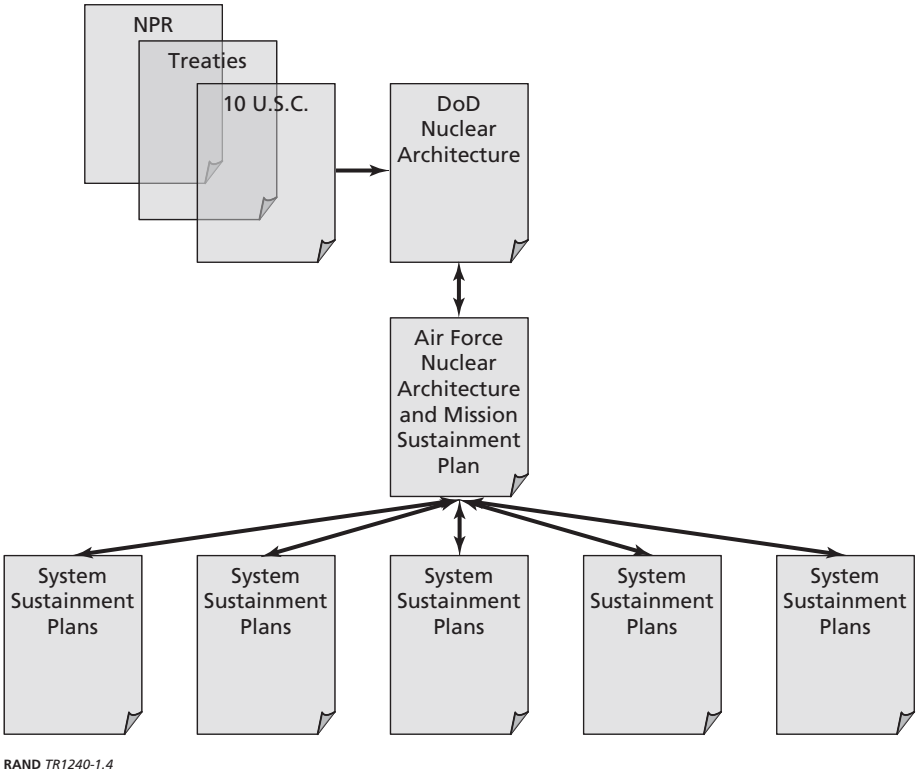
An Integrated View

The breadth and complexity of sustaining the nuclear mission place it beyond the direct, centralized control of one organization. Higher levels in the nuclear enterprise set the overall goals, allocate and balance resources, and adjudicate conflicting schedules. Lower levels oversee the detailed plans for systems and execute the sustainment activities. So, for each of the current platforms—each dot (system) in Figure 1.2—there would ideally be a life-cycle sustainment plan. To assist in coordination across systems, each of these plans would use a common framework[10] and include a scheduling calendar that takes into account effects on related systems (as depicted by the links in Figure 1.2). All of these plans would have a scope that looks beyond the platform itself (the materiel in DOTMLPF), to the full range of DOTMLPF elements to the degree they are applicable, especially the sustainment of human capital (the personnel in DOTMLPF). And, as the nuclear mission crosses an agency boundary, we must include in this list life-extension plans for each of the DoE-managed weapons, even though these lie outside Air Force direct control. These plans form the lower row of documents in Figure 1.4.

To manage the sustainment of the capability or mission, an integrated master plan must be created that pulls together the salient aspects of the individual system plans, especially in areas that require integration across systems. We call this an Air Force Nuclear Architecture and Mission Sustainment Plan, and it is shown schematically in the intermediate level in Figure 1.4. This plan would integrate individual plans into a master schedule for all systems, taking into account the sustainment of the current platforms and any need for future recapital-

[10] For example, as in the template specified in AFPAM 63-128, 2009.

Figure 1.4
Proposed Schematic Hierarchy of Nuclear Mission Sustainment Plans

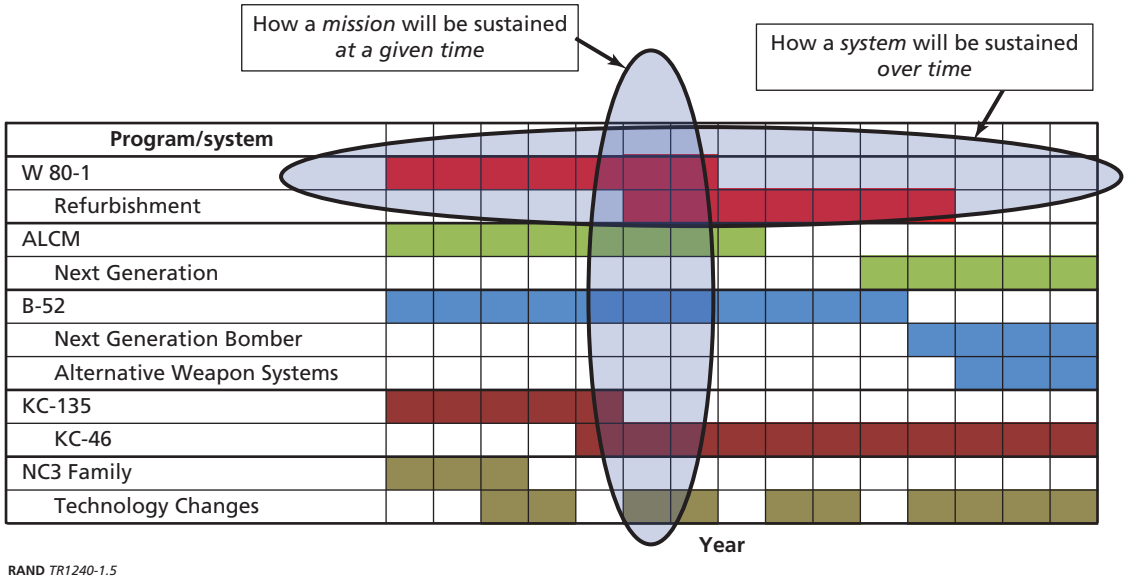


ization. The latter would include architectural information for key junctures in the future, such as that presented in Figures 1.2 and 1.3. It would be the master plan for the nuclear enterprise, detailing how the long-term mission will be sustained. As shown schematically in Figure 1.5, for any time in the future, it would give an integrated (vertical) view of the sustainment of a mission to complement the system-based (horizontal) plans maintained by the program offices. The recently created Nuclear Deterrence Core Function Master Plan has similar objectives, but that plan so far lacks the overall integration and detailed scheduling we are discussing, focusing instead on gaps that need to be addressed in near-term programming.

Ideally, the DoD would also have a similar plan for the entire nuclear mission, currently in the form of the triad that spans the Air Force and the Navy. The Air Force plan could help shape such a DoD-level architecture for the nuclear triad and be shaped by it as the Navy's contribution to the mission changes over time. All would be guided and bounded by national-level policy direction such as the NPR, treaties, and congressional statutes.

Finally, it is prudent to monitor any departures of nuclear capabilities from those called for by national guidance. This exercise is continuously done at the operational level in the Air Force, but there is also a need for visibility, given programmed sustainment plans, into the projected state of nuclear capabilities into the future and how that state compares to national objectives. This projected state would look across the DOTMLPF areas, for both sustainment of current platforms and the planned or programmed future force mix. The proposed Air

Figure 1.5
Notional Mission-Based Plans for the Nuclear-Standoff Mission



Force Nuclear Architecture and Mission Sustainment Plan would form the baseline for this assessment.

An appropriate set of measures is needed to capture any potential future gaps between the capabilities the nation wants and those the Air Force is likely to be able to provide with programs of record. As mentioned above, defining these metrics is a challenge for the nuclear mission, given the political dimensions of deterrence, but is a necessary component to risk assessment. We take up this and other challenges in the next chapter and suggest possible improvements to the sustainment of the Air Force nuclear mission.

CHAPTER TWO

Challenges and Policy Options to Meet Them

> "Experienced teams have integrated identities; the members identify themselves in relationship to the whole team. Inexperienced teams have fragmentary identities and focus on individual assignments more than team requirements."
>
> — Gary Klein[1]

Although fully implementing the framework described in Chapter One for the sustainment of the Air Force nuclear mission is an ambitious endeavor, most of the basic elements are already in place. Nevertheless, challenges remain. A few elements in the scheme are lacking and would need to be created, and some additional integration and coordination among existing elements would reduce risk. In light of this framework, in this chapter we discuss the gaps in the realization of the framework and areas where current integration and coordination is problematic.

System-Level Sustainment Plans

Nuclear Command, Control, and Communications

Given the proposed framework in Figure 1.4, we note that, for nearly every system (indicated by the dots in Figure 1.2), some organization exists that has responsibility for the sustaining engineering and life-cycle sustainment plans that occupy the lower row of plans in Figure 1.4. For nuclear weapons, these are interagency integrated project teams called project officers groups (POGs), led by a lead project officer (LPO).[2] For the weapon systems (missiles and aircraft), these are the system program offices (SPOs), led by system program directors and program executive officers (PEOs). And the various systems that make up the ITW capabilities also have SPOs (e.g., Pave Paws, Space-Based Infrared System).

But there is a glaring exception: No single organization oversees NC3 systems. NC3 systems reside in both the Air Force and Navy, with the Air Force operating roughly three-quarters of them. The various systems that constitute the Air Force portion of the NC3 system are scattered throughout the Air Force, with many under the operational purview of the Air

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[1] Gary Klein, *Sources of Power: How People Make Decisions,* Cambridge, Mass.: The Massachusetts Institute of Technology Press, 1998, p. 242.

[2] Air Force Instruction (AFI) 63-103, *Joint Air Force-National Nuclear Security Administration (AF-NNSA) Nuclear Weapons Life Cycle Management,* September 24, 2008.

Force Global Strike Command (AFGSC). No single organization is responsible for the overall Air Force NC3 architecture, systems engineering, or sustaining engineering. Oversight was further complicated by the initial placement of NC3 planning, programming, and risk assessment under the Command and Control Core Function Lead Integrator (CFLI), thus separating it from the rest of the nuclear mission, which falls within the remit of the Nuclear Deterrence CFLI.

The result is no life-cycle sustainment plan for NC3 analogous to those produced by the SPOs for the weapon systems or the plans for the weapons developed by the National Nuclear Security Administration (NNSA) and the POGs.[3] The lack of such stewardship and plans has obvious implications for the risks incurred in the sustainment of NC3, but it also has consequences beyond NC3. NC3 sits at the center of the network of systems that combine to fulfill the nuclear mission (Figure 1.2) and hence is a vital node on which the rest of the nuclear mission system of systems relies.

Any ambiguities in the future schedule for changes in the NC3 systems, capabilities, or architecture can have a negative effect on the schedule slips and sustainment costs of the related systems. Not having a clear, coordinated plan for the architecture, systems engineering, and sustaining engineering for NC3 impedes the ability to assemble and monitor the proposed Air Force Nuclear Architecture and Mission Sustainment Plan and to most effectively and efficiently plan and program using the current Nuclear Deterrence Core Function Master Plan.

Therefore, the most important proposed change would be *to consolidate responsibility for the architecture, systems engineering, and sustaining engineering for Air Force NC3 into a single organization*. This organization would also be responsible for issuing a life-cycle sustainment plan for NC3. There are several organizational options to accomplish this consolidation, all having some merits and some shortcomings. As these activities are normally done in the field in program offices or product centers, we do not entertain options for placing these responsibilities on the Air Staff. The three options we examine are to (1) create a system program office for NC3 and place it in Air Force Materiel Command (AFMC) under the Air Force Nuclear Weapons Center (AFNWC), (2) place the responsibilities for NC3 in a consolidated directorate in AFMC under the Electronic Systems Center (ESC)[4] with other command and control (C2) systems, and (3) consolidate the activities in an organization within the AFGSC, perhaps reporting to the Air Force Directorate of Communications and Information (AFGSC/A6).

Consider first the creation of a system program office for NC3 under the AFNWC. Systems engineering and sustaining engineering are typically done within SPOs, and these are normally placed in AFMC. As the NC3 family of systems is solely for the nuclear mission, and the AFNWC was established to unite nuclear sustainment under a single organization, a system program office for NC3 at AFNWC seems a logical choice. The principal drawback to such a solution is that many personnel involved in NC3 are distributed throughout the Air Force (many not in AFMC), and their NC3 responsibilities are intertwined with other tasks.

Disentangling these NC3 responsibilities and unifying them into one center would be a challenge. Yet this challenge is common to all options and must be overcome to realize the

[3] National Nuclear Security Administration, *Annex A: FY 2011 Stockpile Stewardship Plan,* Washington, D.C.: U.S. Department of Energy, May 2010.

[4] The ESC was to be subsumed into the Air Force Life Cycle Management Center under AFMC by October 2012.

benefits of consolidated oversight of NC3. This challenge might be addressed by creating a "virtual" SPO at the AFNWC at Kirtland Air Force Base, while leaving most of the personnel at their current locations. This concept has been employed by the Air Force Global Logistics Support Center (AFGLSC), where most of the personnel who report to the center reside outside the headquarters at Scott Air Force Base.[5]

A second option is to place oversight of the NC3 architecture, systems engineering, and sustaining engineering under the command and control PEO at ESC. The logic of such a placement would be to keep the C2 systems under a single organization and a single PEO and maintain Air Force doctrinal consistency of a single C2 system.[6] Given that (1) there is little overlap with other C2 systems and (2) that placing NC3 in ESC would separate this sustainment activity from all the other nuclear sustainment activities, it is not clear that the benefits warrant removing this oversight from either the AFNWC or AFGSC. Additionally, acquisition is ESC's primary expertise, not systems engineering and sustaining engineering.

A third option is to place these responsibilities in an organization within AFGSC. Here, the rationale is that AFGSC operates the majority of the NC3 systems and therefore is best positioned to oversee the architecture and sustainment. But, the activities that are needed for the NC3 mission sustainment involve detailed engineering such as that done in a system program office—including modeling, simulation, and integration, which generally require many hundreds of individuals. This is a greater number of tasks than is normally placed on a staff, and such tasks are not intrinsic staff responsibilities. These factors point to creating a separate organization, perhaps within a center, for NC3 sustainment. Whereas it is one of AFMC's core competencies to oversee life-cycle sustainment, the AFGSC has an operational mission, and as such an NC3 sustainment organization seems better placed in AFMC than in an operational command. As a force provider to the U.S. Strategic Command (USSTRATCOM), operational requirements for NC3 would originate in AFGSC.

Whichever option might be adopted, consolidation of the oversight of NC3 architecture, systems engineering, and sustaining engineering would strengthen the overall management of the sustainment of the Air Force nuclear mission.

Other System-Level Sustainment Plans

Beyond the NC3 systems, the other systems (the dots in Figure 1.2) have some form of life-cycle sustainment plans. Air Force guidance on the form of these plans is moving toward embracing a wider range of DOTMLPF elements, which will strengthen the Air Force's ability to plan for sustainment. These plans could be further strengthened by an eventual evolution from text-dominated documents to at least having a component that exploits modern information technology scheduling tools. Having scheduling details, as well as future recapitalization schedules, in a common electronic format would facilitate monitoring and oversight of the sustainment of the Air Force nuclear mission.

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[5] For example, item managers at system program offices still reside there but now report to the AFGLSC (which was to be subsumed into the new Air Force Sustainment Center by October 2012).

[6] Similar to the placement of NC3 planning, programming, and risk assessment under the C2 CFLI rather than the Nuclear Deterrence CFLI.

An Air Force Nuclear Architecture and Mission Sustainment Plan

Sustainment plans for each individual nuclear system that outline how the complete span of DOTMLPF elements of the system are to be sustained, and a planned schedule for these activities, provide a solid backbone for an overall Air Force Nuclear Architecture and Mission Sustainment Plan (Figure 1.4). This nuclear enterprise–wide plan would integrate the system plans, outline any planned new systems and the schedule for their introduction, provide an integrated calendar for all activities, and serve as a baseline for risk assessments related to meeting national nuclear deterrence objectives.

The Nuclear Deterrence Core Function Master Plan provides some of this integration. This plan is a relatively new, still-evolving construct that is part of a set of 12 mutually constructed documents meant to express the Air Force's strategic plans, programming guidance, and risk assessment.[7] As part of this ensemble, the Nuclear Deterrence Core Function Master Plan must address some specific topics and conform to a certain template. Given that constraint, along with an already burdened staff that develops the Nuclear Deterrence Core Function Master Plan, it would probably be wise to craft a separate plan that serves the role we describe here and is indicated in the schematic in Figure 1.4.

As the supporting plans migrate to include a common electronic database of schedules, a core component of this plan would be an electronic database of the major planned and scheduled sustainment activities. For any mission in Figure 1.2, for example, it would include the calendar of activities for the life-extension program of any nuclear weapons, the sustainment activities for the weapon systems, any modernization programs and their milestones, and any proposed new programs and their milestones. This master calendar would reveal and help manage system interdependencies and reduce the risk of schedule slips and related cost growth. As such, it would support, rather than compete with, the construction of the Nuclear Deterrence Core Function Master Plan as well as the nuclear portion of the program objective memorandum build.

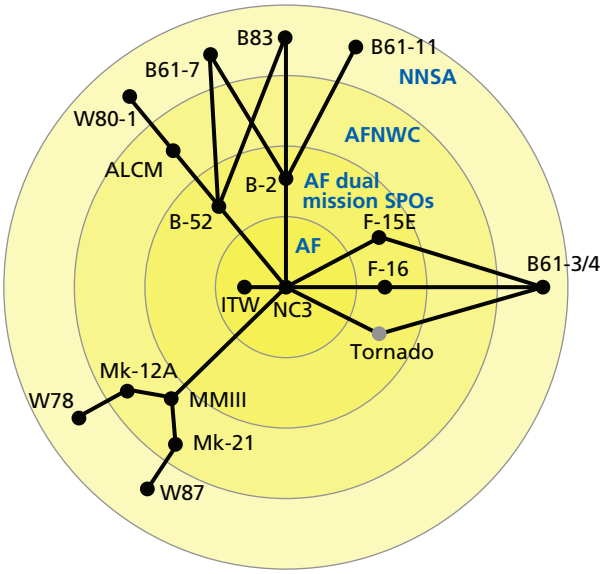
Improved Interagency Coordination and Advocacy

One unique challenge of the nuclear mission is that the key systems that directly produce the military effects—the nuclear weapons—lie outside Air Force control. The DoE owns the nation's nuclear weapons and has responsibility for ensuring that the DoD possesses safe, secure, and effective weapons that meet military objectives. Absent the design of new weapons, the DoE accomplishes this mission through refurbishing all the weapons in the active stockpile in the form of life-extension programs executed by the national laboratories and production facilities, under the oversight of the NNSA. The organizational boundaries are depicted in Figure 2.1.

Figure 2.1 is the same as Figure 1.2 except that it groups the systems by organizational responsibilities rather than by capabilities or missions. The outer ring contains the nuclear weapons, all under the responsibility of the NNSA. The next ring inward contains the deliv-

[7] As of 2011, the 12 are Nuclear Deterrence Operations; Air Superiority; Space Superiority; Cyberspace Superiority; Global Precision Attack; Rapid Global Mobility; Special Operations; Global Integrated Intelligence, Surveillance, and Reconnaissance; Command and Control; Personnel Recovery; Building Partnerships; and Agile Combat Support.

Figure 2.1
Organizational Divisions Within the Air Force Nuclear Mission



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ery systems, whose sustainment falls under the responsibilities of the AFNWC. The next ring contains dual mission systems, each with its own program office. And, finally, the inner core contains the ITW, with its various system program offices, and the NC3, which lack consolidated oversight. That is to say, organizational boundaries facilitate coordination and integration along the contours of the rings in Figure 2.l, not the mission boundaries indicated in Figure 1.2.

The interagency boundary is the most challenging. Many activities are done to sustain the nuclear stockpile in the outer ring of Figure 2.1. Among these is the replacement of limited-life components in the weapon and refurbishment programs to extend the service life of the weapons. These activities, to varying degrees, require production capacity at various NNSA facilities. NNSA production capacity is finite and very costly to expand. Consequently, NNSA has an incentive to advocate for a plan for weapon sustainment, especially the scheduling of activities, around the constraint of balancing NNSA production requirements. Although these constraints are real and need to be considered, this incentive pushes against the spirit of capabilities-based planning. Consider the example of the W80, the warhead the Air Force uses in the ALCM.

Los Alamos National Laboratory started refurbishment of the W80 in September 1998. For workload-balancing reasons internal to DoE, NNSA transferred this project to the Lawrence Livermore National Laboratory in January 2001. Initial plans were to complete first production of a refurbished W80 by 2006. Numerous schedule slips occurred, many from lack of coordination between the W80 refurbishment program and refurbishments to DoE infrastructure on which it relied. The program was troubled by 2003.[8] In May 2006, after

[8] U.S. Department of Energy, *Audit Report: Refurbishment of the W80–Weapon Type,* Washington, D.C., DOE/IG-0590, March 2003.

the belated completion of Phase 6.2,[9] the Nuclear Weapons Council (NWC) directed that the W80 life-extension program be ceased, either "to support NNSA efforts to transform the nuclear weapons complex and continue work on a RRW [Reliable Replacement Warhead],"[10] or "because DOD planned to reduce the number of W80 warheads in the nuclear stockpile" and corresponding ALCM force structure,[11] or both. Summing up the total cost is elusive, but the GAO estimates that the NNSA activities from 2003–2007 on the W80 cost about $480 million.[12] As of 2011, starting any new life-extension program for the W80 (and weapon system integration) is at least a decade in the future, with projected production not starting before 2030.[13]

Meanwhile, the Air Force has been working to sustain all the other systems necessary to employ the W80. Unpredictable scheduling, and in the case of the W80, eventual cancellation, causes perturbations in the service life–extension programs and recapitalization efforts of these Air Force systems. Looking back at Figure 1.2, to sustain this nuclear mission in an effective and efficient manner, there is a need for an integrated schedule and balancing of resource allocations across the W80, the ALCM that carries it, the B-52H that carries the ALCM, and the relevant NC3 systems.

Fielding of the ALCM was completed in 1986, with a required design life of ten years. In 1996, the required service life was extended to 2030, and, since then, there have been a number of initiatives, some ongoing, carried out by the ALCM system program office.[14] To sustain this capability beyond 2030, the Air Force has analyzed alternatives for a possible replacement, as required by the NPR.[15] The service life of the B-52H, the youngest of which came off the production line in 1962, has been extended beyond 2040, with a number of planned initiatives by its program office to carry this out. And, as noted above, there is no coordinated plan for NC3 for the other programs to reference. Given all of this, what effect has the troubled life-extension program for the W80 had on the cost and effectiveness of the long-term sustainment of the Air Force long-range standoff nuclear mission?

Unfortunately, NNSA can answer the question of how a schedule perturbation in a weapon's life-extension program will affect other weapons and can estimate the cost of increasing the production capacity to mitigate that effect more effectively than the Air Force can answer the question of how that perturbation affects the nuclear mission and the cost implications to programs such as the ALCM, B-52H, and NC3 systems. Admittedly, NNSA's challenge is an easier one than the Air Force's. But this is a core ability that the Air Force can augment

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[9] The overall process for managing nuclear weapon refurbishment is called the *6.X process* and plays the role that the "5000 series" oversight plays in DoD acquisitions. See Department of Defense Instruction 5030.55, *DoD Procedures for Joint DoD-DOE Nuclear Weapons Life-Cycle Activities,* January 25, 2001; and AFI 63-103, 2008.

[10] Thomas P. D'Agostino, "Statement of Thomas P. D'Agostino, Acting Under Secretary for Nuclear Security and Administrator, National Nuclear Security Administration, U.S. Department of Energy, Before the House Committee on Armed Services Subcommittee on Strategic Forces," March 20, 2007.

[11] Government Accountability Office (GAO), *NNSA and DOD Need to More Effectively Manage the Stockpile Life Extension Program,* Washington, D.C., GAO-09-385, March 2009, p. 11.

[12] GAO, 2009, p. 11.

[13] GAO, *DOD and NNSA Need to Better Manage Scope of Future Refurbishments and Risks to Maintaining U.S. Commitments to NATO,* Washington, D.C., GAO-11-387, May 2011.

[14] Called the ALCM Missile Sustainment Division, AFNWC 498 NSW/NWB.

[15] DoD, 2010, p. 24.

to improve interagency advocacy for the nuclear mission and plan for the sustainment of the nuclear mission with a mission-based framework.

Adjusting schedules and requirements inflicts costs. The cost consequences of various sustainment courses of action are currently more easily assessed on the NNSA side than on the Air Force side of the nuclear mission. The Air Force lacks the integrated view of scheduling and cost that it needs to assess various courses of action as well as NNSA can. It might be the case that it is in the national interest to accept additional costs and risks on the Air Force side. But the nation would enter into such decisions with more insight of the costs and risks if the Air Force had a stronger mission-based view of nuclear sustainment.

All of this reinforces the need for an integrated Air Force plan such as the proposed Air Force Nuclear Architecture and Mission Sustainment Plan (Figure 1.4). This plan would support the Air Force in its advocacy for sustaining the nuclear mission in the interagency adjudication process—a process that has not always worked elegantly, as documented by the GAO.[16] Where and how might such a plan be used? Interagency coordination for nuclear weapons is managed at various levels. At the highest level, the NWC was established by Congress in 1987 to coordinate "programming and budget matters pertaining to nuclear weapons programs between the Department of Defense and the Department of Energy" and to identify "various options for cost-effective schedules for nuclear weapons production."[17] The responsibilities of the NWC are directed by law, and the membership is at a high level, suitable for adjudicating interagency issues, but too high for day-to-day planning of how to sustain the nuclear mission.

That task falls to two relevant subordinate organizations called the Nuclear Weapons Council Standing and Safety Committee, which has membership at the flag officer level, and the Transformation Coordinating Committee, established in 2005. And, at the working level, each weapon has a POG, which acts as an interagency integrated product team, and an LPO from the Air Force to head that team. This overall structure for interagency coordination is outside Air Force control, but the Air Force can use the proposed Air Force Nuclear Architecture and Mission Sustainment Plan to advocate for a mission-based view of sustainment, express the mission and cost consequences of various potential courses of action, and do so with a single voice.

Maintaining Human Capital

The health of human capital in most enterprises ebbs and flows over time, and the nuclear enterprise is no exception. From today's vantage point, it might seem that all was robust in the early decades of the nuclear age, especially in the immediate period after the Manhattan Project when the technologies were fresh, new discoveries were being made frequently, and the bomb was at the forefront of national military power. Yet, when David Lilienthal visited Los Alamos in February 1946, he observed that

[16] GAO, 2009; GAO, 2011.

[17] See 10 U.S.C. Section 179 for the full set of responsibilities. The five members of the NWC are the Under Secretary of Defense for Acquisition, Technology, and Logistics; the Vice Chairman of the Joint Chiefs of Staff; the Under Secretary for Nuclear Security of the Department of Energy; the Under Secretary of Defense for Policy; and the commander of USSTRATCOM.

> Deterioration had set in. . . . Scientists had left the project in large numbers. Contractors had declined to go forward. . . . There was great uncertainty. Morale was badly shot. At Los Alamos we found the most serious situation because although some very able men remained, the top management of the project had left for the universities. We found a great many health hazards and fire hazards that were very damaging to morale. . . . The net effect of that was a very depressed state of mind.[18]

The national nuclear enterprise climbed out of that depression in morale by an infusion of money and a growth in the enterprise. Given the national climate and NPR guidance, that is an unlikely path today for strengthening and preserving nuclear human capital in the Air Force. It must find another path.

The problem with sustaining nuclear human capital is a well-known one in the Air Force nuclear enterprise and needs no elaboration here. Rebuilding and strengthening the nuclear workforce is not possible overnight. Finding the most promising path to sustaining human capital was not a central focus of this work, but as a key component of the DOTMLPF ensemble of elements that provide a sustained nuclear capability, it needs to be part of the overall sustainment plans, at both the system and enterprise level. Sustainment does not just refer to platforms.

If, as is likely, funding levels decrease in the near future and the goal of the United States remains to reduce "the role and numbers of U.S. nuclear weapons,"[19] the challenge of maintaining the requisite levels of nuclear expertise will grow. The challenge, then, will take two forms: The overall size of the force is likely to be smaller in the future, and as the role of the nuclear mission is perceived to be less important to the country, it may be more difficult to attract and retain the high-quality workforce needed. This issue spans the military, civilian, and the industrial-base sectors. The most troublesome area for both morale and the ability to maintain deep, specialized knowledge in a small force is with jobs directly involving the weapons themselves, more so than with the platforms that deliver them, where there is more commonality in tasks and expertise within the rest of the Air Force. And, the Air Force also needs to continue cultivating a deeper knowledge of nuclear strategy and deterrence across the force to ensure that all airmen understand and appreciate the purpose and importance of the mission.

One avenue worth exploring that was beyond the scope of what could be addressed in this study is the expanded use of incentives, both within the Air Force and in the DoD/DoE relationship. Several decades ago, there was general concern regarding a lack of strong joint coordination in the DoD.[20] Joint training was infrequent, and the services did not always send their best personnel into joint billets. The result was shortfalls in the effectiveness of joint operations. A policy solution using incentives was implemented in the form of the Goldwater Nichols Act of 1986,[21] which mandated in part that "an officer may not be selected for promotion to the grade of brigadier general or rear admiral (lower half) unless the officer has served

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[18] Robert Jungk, *Brighter Than a Thousand Suns,* New York: Harcourt, Brace, and Company, 1958, p. 242, as quoted in Gerard J. DeGroot, *The Bomb: A Life,* Cambridge, Mass.: Harvard University Press, 2005, p. 159.

[19] DoD, 2010, p. 7.

[20] See, for example, Gordon Lederman, *Reorganizing the Joint Chiefs of Staff: The Goldwater-Nichols Act of 1986*, Westport, Conn.: Greenwood Press, 1999.

[21] Public Law 99-433.

in a joint duty assignment."[22] Perhaps some mandatory nuclear experience for some types of promotion, either within the Air Force or across agencies, might help sustain a viable nuclear workforce. Whatever the course of action, this important component of DOTMLPF must be emphasized in all sustainment plans.

Metrics

The effects of nuclear weapons dwarf the effects of all other weapons and are unique.[23] They are special weapons in the nation's quiver. The threshold for their employment is consequently higher than that of all other weapons, yet they have political effectiveness merely by their existence and the credible threat of their use. The measures of effectiveness for nuclear weapon systems must reflect these characteristics and hence differ from those of other weapon systems. Well-crafted metrics are necessary to best evaluate and prioritize planned sustainment activities—ones that address the following nuclear-specific questions:

- How does the sustainment activity alter the USSTRATCOM commander's ability to carry out the military mission(s) in his plans?
- How does the sustainment activity alter the perception by any adversaries of the credibility of the U.S. nuclear deterrent?

These are difficult attributes to capture quantitatively in a metric. Current metrics for sustainment do not differ appreciably from those applied to conventional weapon systems. These focus on measuring, in some sense, how many of the platforms are operable. For aircraft, this metric is aircraft availability; for ICBMs, this is some form of an alert status. These are useful measures to be sure, but the Air Force can go one step further to embrace the broader attributes of the nuclear mission.

Mission assurance has multiple layers: availability and alert rate, reliability, and survivability. Sustainment activities contribute to all of these. The goal is to extend the metrics into these domains in ways that address the above questions. The metrics are most useful when all three of these aspects of mission assurance are tied directly to USSTRATCOM operational plans to indicate the effect of the sustainment activity on the ability to carry out operational plans. Beyond mission assurance, it is also important for the nuclear mission to capture how visible the sustainment activity is to the credibility of the deterrent, and how those actions will be perceived. An example is the success of ICBM test launches out of Vandenberg Air Force Base, which serve not only a test purpose but also one of deterrence by demonstrating a credible capability.

Crafting metrics that capture this wider range of sustainment's contributions to national goals will take time and considerable effort. We outline here only the general attributes these metrics should possess. Developing them will involve a collaborative effort cutting across the

[22] Goldwater Nichols Act of 1986, Section 404, subsequently amended in 10 U.S.C. Section 619a.

[23] Samuel Glasstone and Phillip J. Dolan, *The Effects of Nuclear Weapons*, 3rd ed., Washington, D.C.: Department of Defense and Department of Energy, 1977, summarize the direct effects. Large-scale employment might also induce the global effect of a "nuclear winter" scenario; see Owen B. Toon, Alan Robock, and Richard P. Turco, "Environmental Consequences of Nuclear War," *Physics Today,* December 2008, pp. 37–42, for a recent review.

sustainment community, the operators, and USSTRATCOM. But that effort will pay off with improved prioritization decisions that define a clear audit trail during programming deliberations of how any resource allocation decision for sustainment supports national objectives and any risks it might introduce.

Summary

The biggest challenge facing the Air Force nuclear enterprise in the near future is likely to be how to cope with declining total obligation authority and a smaller force structure. These are problems of sustainment in the broadest sense. We propose that to position itself most strongly to overcome these challenges, the Air Force must further strengthen its integrated processes for capabilities-based planning for the sustainment of the nuclear mission, taking a broad DOTMLPF perspective.

Most of the needed elements are in place, but some additions could potentially pay great dividends. We make a number of recommendations in this report, but in the hierarchy of actions required to put in place a complete mission-based planning process for sustainment, the two most promising first steps are to

- consolidate responsibility for the architecture, systems engineering, and sustaining engineering for Air Force NC3 into a single organization
- create what we call an Air Force Nuclear Architecture and Mission Sustainment Plan that integrates the sustainment plans of all the nuclear systems, emphasizing an integrated master calendar of activities, and in time presenting and monitoring these plans via the capabilities of modern information technology systems.

The immediate benefits would be to improve oversight of the NC3 mission, to better integrate prioritization decisions across interrelated nuclear systems and to better monitor and manage an integrated set of DOTMLPF-based plans for sustaining the most effective and efficient nuclear mission into the future.

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